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ABSTRACT

This document might easily have been called "How To Use Trees To Save Energy". It presents the energy saving advantages of landscaping the home and community with trees. The discussion includes: (1) landscaping advice to obtain the benefits of tree shade; (2) the heat island phenomenon in cities; (3) how and where to properly plant trees for desired outcomes; (4) the winter benefits of trees; and (5) environmental and energy benefits of utilizing tree trimmings for fuel. Additional sources of information about trees and conservation are described on the back cover of the bulletin. (MCO)

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Bulletin No. 21
James R. Fazio, Editor

TREE CITY USA
BULLETIN
for the
Friends of Tree City USA

ED356956

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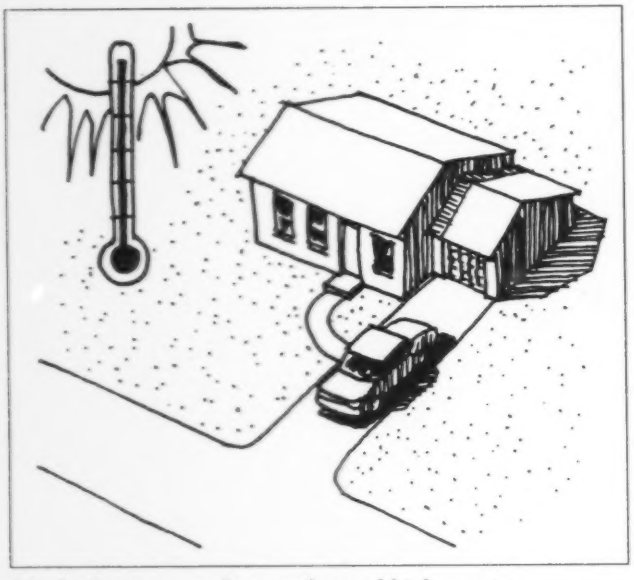
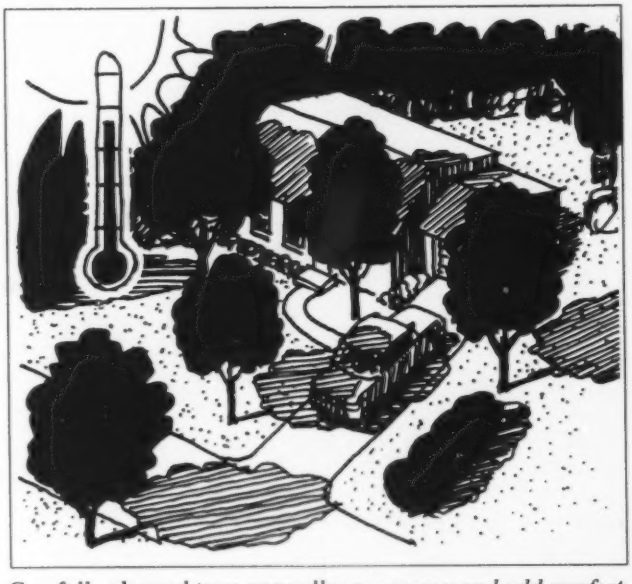
How Trees Can Save Energy



A lack of trees means less comfort and higher costs.



Carefully planned trees annually save money and add comfort.

Trees have been called the "low tech" solution to energy problems. Whether you want to reduce the amount of money you spend each month on utility bills, or help guide your community toward wiser energy policies, the information in this *Bulletin* is of special importance.

There is an on-going debate among community forestry leaders about the best approach to convincing citizens and city councils about the importance of trees. Some suggest that aesthetics and liveable communities are the issues to promote. Others believe that the practical contributions of trees will tug at heart strings (and purse strings) more effectively. The National Arbor Day Foundation takes the position that both appeals are correct. However, in this issue of the *Bulletin*, emphasis is decidedly on the practical.

The role of trees in saving energy has yet to be discovered by large numbers of people. When it is, a major step can be taken not only toward saving individual home and business owners a lot of money, but also toward less dependence on foreign oil and domestic sources of diminishing fossil fuels.

Trees can save energy many ways: (1) through shade, reducing the need for air conditioning, (2) through breaking the force of winter winds, lowering heating costs, and (3) by serving as a renewable source of fuel — and one that burns with less air pollution than other fuels when the right equipment is used. There are more subtle ways that trees contribute to energy savings. One is by sequestering, or "locking up" carbon, an element that is a key villain in atmospheric pollution and the threat of global warming. Another is by landscaping with trees to reduce lawn space and the need for power mowing.

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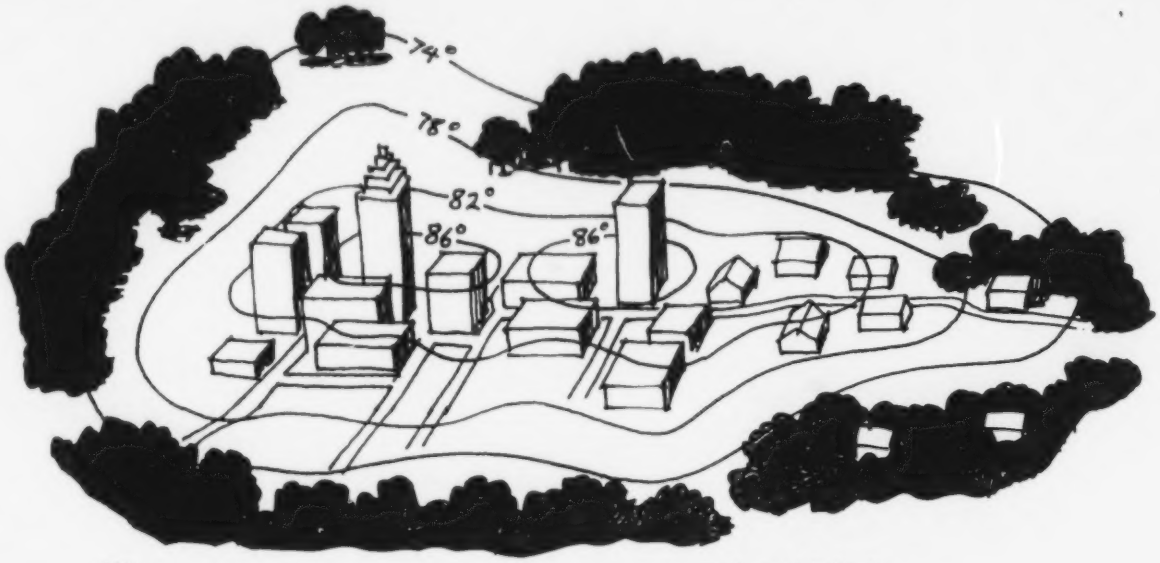
The Heat Island Phenomenon

If it seems hotter downtown than in the suburbs, and cooler in the park than in your backyard, it is not simply your imagination. Cities are "heat islands" — zones of summer air temperatures of as much as 12 degrees Fahrenheit higher than surrounding areas.



Cities

- More engines and building exhaust
- Few trees
- Buildings, sidewalks and streets absorb and hold heat
- Dust and other air pollutants absorb and trap heat
- Concrete and asphalt hasten the drainage of rainfall

Parks and Suburbs

- Fewer sources of heat
- More trees to provide shade, absorb solar radiation and provide natural air conditioning through transpiration
- Cleaner air allows heat to escape into space
- Unpaved open areas retain natural moisture longer, helping to cool the air directly and to supply roots with moisture for tree health and transpiration

How to help:

- ✓ Support efforts to reduce air pollution.
- ✓ Reduce energy use through personal daily habits and by purchasing energy-saving cars and appliances.
- ✓ Protect open space areas such as parks and greenbelts.
- ✓ Plant trees! Trees help cool cities and clean the air.

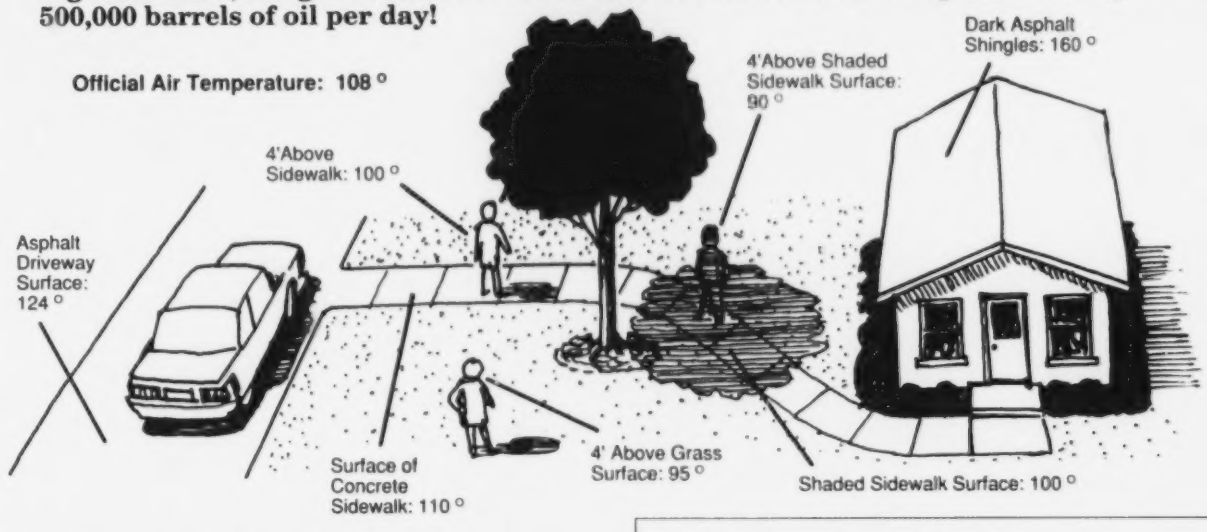
Widespread warming is an alarming trend, with an increase in the temperatures of American cities measured at a rate of 1 degree Fahrenheit per decade. At first, a 1 degree temperature increase seems too small to cause worry, but a 1 degree increase in Los Angeles' summer temperatures each decade since 1940 has been estimated by scientists at Lawrence Berkeley Laboratory to cost consumers $150 million extra per year. The slight rise in air temperature also contributes to more days of high smog levels each year. And, like adding insult to injury, approximately one additional pound of carbon is dumped into the air for each kilowatt-hour of electricity generated by a coal-fired power plant.

City heat islands and global warming are problems that can be addressed, at least in part, by personal action. According to a USDA Forest Service report, the average tree cover density in single family, residential areas in the United States is 28 percent. These trees are the results of tree boards, community foresters, arborists and dedicated citizens who have planted along the streets and on private property. The current canopy density translates to energy savings of almost $2 billion per year, or about .5 percent of all energy use in the United States.

Using the tips presented in *Bulletin 21*, a few more well-positioned trees in the yards, parks and along the streets of your community could increase the effectiveness of the canopy exponentially. The resulting energy savings can be phenomenal!

Trees for Shade

Home owners and small business operators can make significant cash savings by properly using trees for shade. How much is saved depends on climate, existing tree cover and type of building. However, savings of 58 percent of daytime air conditioning have been documented and as high as 65 percent in the case of mobile homes. Ten percent savings are more common, but even this amount is no small matter in most family budgets. If applied nationwide to buildings not now benefiting from trees, the gift of shade could reduce our nation's consumption of oil by 500,000 barrels of oil per day!


Official Air Temperature: 108 °
4'Above Sidewalk: 100 °
4'Above Shaded Sidewalk Surface: 90 °
Dark Asphalt Shingles: 160 °
Asphalt Driveway Surface: 124 °
Surface of Concrete Sidewalk: 110 °
4' Above Grass Surface: 95 °
Shaded Sidewalk Surface: 100 °

Landscaping is the Key

Shade and surfaces around the house or place of business can have an extreme effect on summer temperatures. The illustration above shows actual temperatures measured on a summer afternoon in Arizona both at ground level and near the level of breathing.

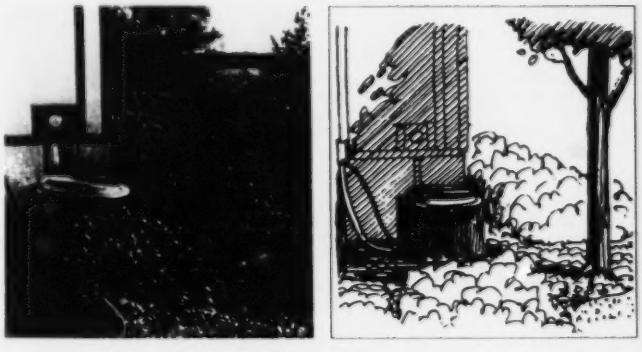
To help trees keep you cool, here are some tips to consider:

1. What to Shade?

- Maximum benefit from shade usually comes from trees on the east and west sides of a building, and close to the walls. A 25-foot tree 10 feet from a west wall may shade 47 percent of the surface in mid-afternoon compared with only 27 percent if planted 20 feet from the wall.
- Prioritize areas of greatest heat gain or importance for comfort.
- Windows! About 3/4 of total solar heat gain in a building comes through windows.
- Dark or rough-textured surfaces absorb more heat than light-colored or smooth surfaces.
- Shading asphalt shingles is more essential than shading cedar shakes.
- Provide shade for "heat sinks" like driveways and parking areas.
- Consider high summer use areas such as patios and porches.
- Shading an air conditioning unit can increase its efficiency by 10 percent.

The Benefits of Shade

- Improved human comfort
- Reduced air conditioning costs
- Reduced peak load demands on utility companies, reducing the chance of power shortages
- Reduced imports of foreign oil and less pressure to develop domestic sources of oil, gas, coal or nuclear power
- Relatively short payback periods on the investment
- Less sunlight damage to carpets, drapes and furniture
- Long-term savings



A simple technique like shading the air conditioner can return immediate savings to homeowners. Be sure not to block air flow.

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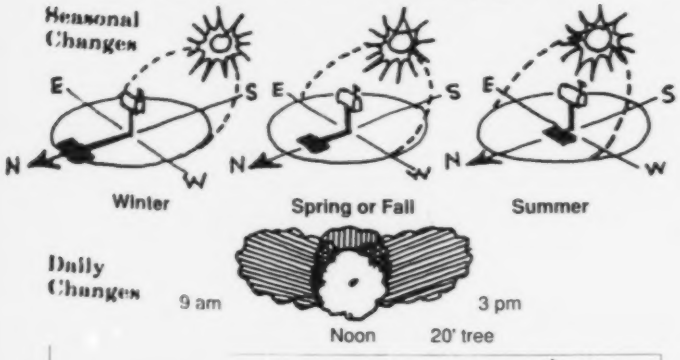
2. When is Shade Needed?

When planning where to plant trees, remember that the sun's position in the sky changes hourly and daily. Plan for shadows that cover targeted areas during the hottest hours of the hottest weeks of summer. Your local power company has temperature data. Then plan tree locations by observing summer shadows on your property or using precision techniques described in the books listed on page 8.



Relative Shade Value of Deciduous Trees

Leaf density and branching characteristics combine to determine the amount of solar radiation that can penetrate the canopy of a tree. The less penetration, the higher a tree's shade value.

Highest	Medium	Lower
Maples	European Birch	Hickories
Horse chestnut	Crabapple	Catalpa
Hackberry	Sweetgum	Ginkgo
Beech	Oaks	Locusts
Green Ash	Littleleaf Linden	Goldenrain Tree
Walnut	Kentucky Coffeetree	Quaking Aspen
Yellow Poplar	Cottonwoods	Pears
Sycamores	Elms	Washington Hawthorn

Additional tips for energy-conscious landscaping:

Cheryl Richter

Espaliers (trees trained to grow in a vertical plane on a trellis) and vines can protect walls from direct solar radiation and create a buffer of cooler air.

T. Davis Sydnor

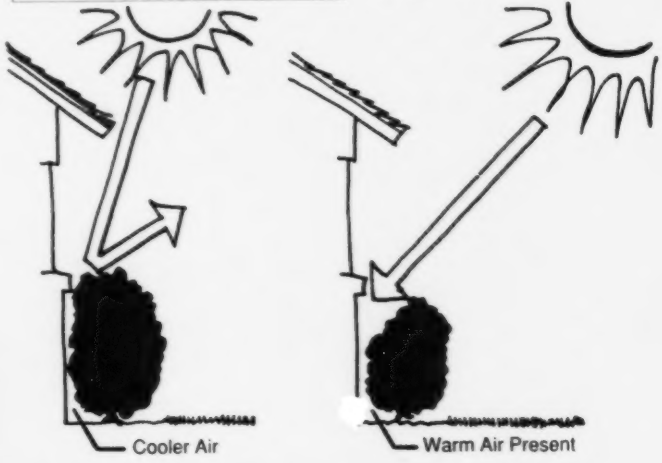
Columnar cultivars are available from many nurseries and can fit within narrow urban spaces to provide shade.

3. What to Plant?

- Tree species with round, horizontal oval and vase-shaped crowns when mature offer the best shading potential. An arborist or nursery professional can recommend suitable species that grow well in your area.

- Select species suited not only for shade, but for your site conditions, space limitations and aesthetic preferences. See *Bulletin 4, The Right Tree for the Right Place.*
- Plant trees with strong wood. Fast-growing species with weaker wood (for example, willows and silver maple) may be useful for quick shade. Stronger, slower-growing trees that are shade tolerant may be interplanted among or next to them. When the slower trees reach a useful height, the weak ones should be removed.
- Plant larger trees or trees on mounds to hasten usefulness for shade. Be sure to monitor watering needs.
- Select trees with dense canopies to maximize blockage of solar radiation.
- Plant groups of trees to intensify shade and reduce lawn area

Have your shade and a view, too. Trees with spreading crowns can be placed near windows for shade and pruned high to keep the view open.



Shrubs are often best along south walls where winter sun helps warm the building. J. H. Parker of Florida International University recommends that arborvitae or similar foundation shrubs be pruned in the fall to help trap sun-warmed air. Spring growth will close the "trap" and provide added shade during the summer.

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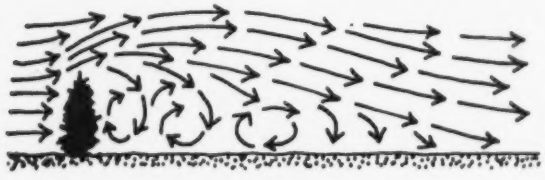
Trees for Winter Warmth

The contribution of trees for winter warmth is often not as appreciated as the shade of summer, but the effect can be just as dramatic. Even in urban areas, widely spaced trees break the force of chilling winds enough to save between 3 and 4 percent on heating bills. This translates to a national savings of $1.6 billion per year in single-family homes alone. With planning and enough space, suburban and rural homes that use windbreaks can save as much as 10-17 percent on the average, with as much as 40 percent being documented in some cases. By slowing winter winds, trees...

- Lower the loss of heat in buildings by reducing cold air infiltration.
- Reduce the drying effect on landscape plants.
- Reduce the abrasive effects of airborne particles.
- Cut down on dust and dirt entering a building.
- Lower wind damage to limbs and buildings.

Trees planted to form windbreaks do their work in 3 ways:



1. Friction and drag caused by the limbs, needles or persistent, broad leaves absorb some of the wind's energy.
2. Winds are deflected upward.
3. The smooth, horizontal force of air is broken up into turbulence.

Distance of Effectiveness

Effectiveness depends on the density of a windbreak and its height. A reasonably dense planting can be expected to provide maximum protection for a distance of up to 8 times the height (H) of the trees as they approach maturity. For planning purposes, 20' is often used as the height at maturity. Protected buildings should be within 2-5 times the height of the trees. Where snowdrifts are a problem, a low-growing "snow trap" row can be planted to the windward of the main windbreak. Otherwise, drifting can be expected to be deepest from 100'to 200' from the windward edge of the windbreak.

How to Plant a Windbreak

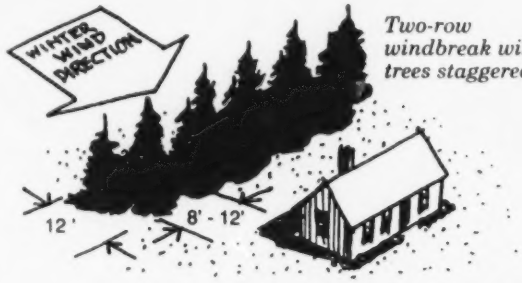
The Cooperative Extension Service, Soil Conservation Service and state forest service have localized literature to help with design and selection of the best species for effective windbreaks. Some general guidelines are:

Species

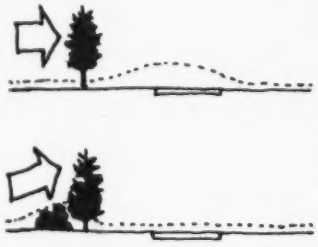
Conifers form the best windbreaks. Depending on local conditions, some of the faster growing favorites are pines such as Austrian, ponderosa and Scotch. Douglas-fir, true firs, redcedar and junipers are also used. Spruces are excellent, but usually grow slowly.

Arrangement

Two or more rows of trees are best if space allows, but even a single row will have an effect. Plant the rows perpendicular to prevailing winter winds. Trees should be spaced closely, 8' to 12' on center, or even as close as 4' to 6' with arborvitae, and 12' between rows. When planting two or more rows, stagger the trees for maximum effect.

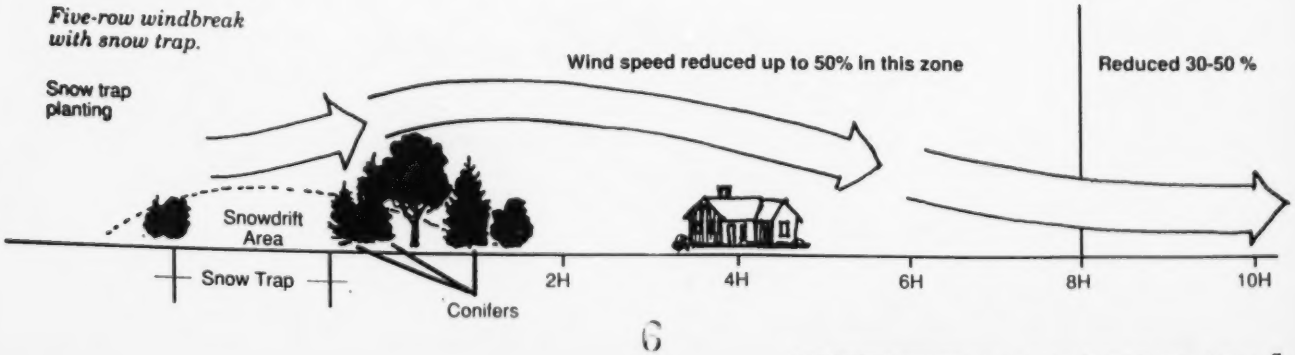


Two-row windbreak with trees staggered.

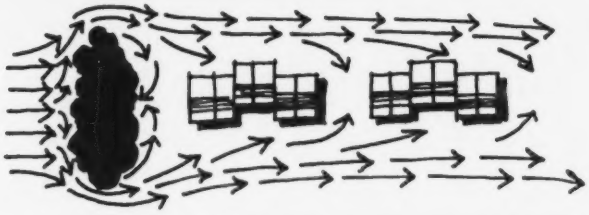


Where space limits plantings, a single row of closely planted conifers and a row of shrubs on the windward side will help reduce wind and control snow drifting. By directing snow away from driveways and walks, energy can be saved by reducing the need for removal.

Five-row windbreak with snow trap.



Designing With Nature Saves on Heating Bills



A clever builder aligned these townhouses parallel with the prevailing winter wind. A single, short windbreak protected the entire complex, with ten of the twelve units further shielded from winter winds by their neighbors.

What NOT to Plant . . .

To maximize winter warmth in northern climes, avoid planting evergreens where they block winter sun from the house. Even some deciduous trees provide as much as 50 percent blockage of winter sun. Where winter warmth is important, select deciduous trees with the most open canopies after their leaves are shed. Species with compound leaves such as Kentucky Coffeetree and honeylocust are examples. Denser trees like pin oaks can be pruned or spaced widely to allow more sun to penetrate.

Energy from Trees

The potential for using trees and waste wood as renewable sources of energy is tremendous. Currently about 4 percent of the nation's energy needs are met by wood, but experts say this could be increased to 20 or 30 percent. The technology and research results are available to put wood energy to work for America without the problems of air pollution, nuclear hazards or foreign dependency. Tradition currently is a significant barrier to wider adoption, but through public education and changes in policy, the day will come when wood plays a larger role in the national energy picture.

Courtesy of Austree, Inc.

This one-year-old tree illustrates the potential for wood to be grown as a renewable energy crop.

To help pave the way by demonstrating the responsible use of wood for energy, The National Arbor Day Foundation is developing a complete fuelwood system to heat and cool its new Lied Conference Center in Nebraska City, Nebraska. The Center will have its own plantation of fast growing trees such as cottonwoods, black locusts and silver maples managed on 5-7 year cutting cycles. When harvested, the trees will produce the next crop from stump sprouts, putting on growth with astonishing speed. Wood for the furnace will also come from street tree prunings and thinnings from private woodlands where the landowner is following a forestry plan approved by the state forester.

The furnace in the conference center will be state-of-the-art, equipped to remove particles and release little more than water vapor into the air.

Environmental Benefits

- Less air pollution, with a net reduction of carbon dioxide and virtually no sulphur dioxide added during combustion.
- Less need for dams, nuclear plants, coal and oil from fragile areas.
- Windbreaks and erosion control.
- Useful recycling opportunities.
- Roots filter out agrochemicals.
- Saves landfill space.

Economic Benefits

- Cost savings on fuel in homes, schools, other buildings.
- Reliable, local sources of renewable fuel.
- Local jobs; money stays in community.
- Expanded markets for farmers.
- A low-input, sustainable crop on marginal lands.

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Trees, Energy and the Community Forestry Program

Energy scarcity and related problems seem to be part of a cyclic phenomenon in the United States. One day conservation energy reform and conservation is front page news. The next it is forgotten. It would appear that both our collective memory and our society's ability to look ahead is somehow wanting.

But the kind of individuals who plant trees and manage forestry programs, long-term problems are no strangers. The foresight and patience that goes into managing trees can well be applied to energy issues. If the consistent attention and action that form the very fabric of community forestry were brought to bear on energy conservation, a major contribution to society and the environment would be made.

There are many ways that energy conservation can become part of a community forestry program. Here are some suggestions.

Sponsor An Energy Fair

A fair or exhibition can bring together the many organizations that are in some way involved with energy conservation. A model for this event is the Midwest Energy Expo sponsored by the Minnesota Energy Council (P.O. Box 8222, St. Paul, MN 55108). Supported by 260 members ranging from window manufacturers to universities, the Expo features three days of exhibits, presentations, demonstrations, films and other special events designed to attract the general public. Trees and landscaping are part of the show, sharing space and exposure to the mass media with super-mileage cars, solar lighting, wind-powered generators and energy-efficient building materials.

An energy fair on any scale, even at the local school level similar to a science fair, is sure to help create a more enlightened public. This is the first step toward energy conservation and wiser energy policies.

Symbolic representation of some of the topics included in Minnesota's Energy Expo.

Include Trees in Energy Audits

Most utility companies offer customers a service intended to help them conserve energy. Windows, weatherstripping, insulation and similar features of the home are examined, followed by recommendations about how improvements can save on heating bills. Some companies, such as the Gainesville Regional Utilities in Florida, already include conservation landscaping in their residential audit programs. Others do not, or will do so only if specifically requested by the home owner.

A good project for a tree board, urban forestry council or similar organization would be to: (1) contact the local utility company and win support for the idea of including trees in conservation audits if this is not already being done, (2) provide samples of appropriate literature for public distribution (such as this *Bulletin*), and (3) provide training for the auditors.

Include Energy Conservation in Tree or Landscape Ordinances

In 1982, John H. Parker of the Florida International University in Miami developed a model energy conservation landscape ordinance that is worth considering in other communities that have hot, humid summer weather.

At the heart of this model ordinance is a method for encouraging energy conservation using trees. In short, if an ordinance requires new developments to retain or create a specific amount of vegetative canopy, developers have the option of reducing this percentage by locating trees and other vegetation in energy-conserving positions. This is done through a "canopy credit system" that is based on the estimated potential energy savings from the vegetation placed to reduce the demand on air conditioning systems.

Plant Trees

With an estimated 60-75 million spaces available for trees to be planted in American cities, and with urban areas spreading into old fields and other open spaces at approximately 800,000 acres per year, it is obvious that planting more trees can help reduce our nation's growing demand for energy. At the same time, trees can help reduce the amount of CO_2 in the air by locking up carbon through photosynthesis and retaining it in its tissues. When burned as fuel, wood also lowers the demand for energy, reducing the amount of CO_2 produced at power stations that use fossil fuels. Trees can make a much more significant contribution to both environmental protection and energy cost savings than is currently the case.

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Other Sources of Information

Tree City USA Bulletin will inform readers about helpful, up-to-date publications that provide more depth, serve as good models, or are readily available for community distribution. The editor welcomes sample copies to consider for inclusion in revised editions of this and other *Bulletins*.

Best Books

There are several excellent books that provide a great amount of detail about how to use trees to save energy, but two of them are out of print. Fortunately, the following book is so rich in all aspects of the topic that it should provide more than enough "how to" information for anyone planning work in this subject:

Energy-Conserving Site Design
edited by E. Gregory McPherson
American Society of Landscape Architects,
4401 Connecticut Ave., NW
Washington, DC 20008-2302.
326 pp., $27.60 ppd.

The following is a book that provides an authoritative and comprehensive overview of the national energy picture and the potential role of trees in helping to reverse global warming and diversify the national energy base:

Minding The Carbon Store: Weighing U.S. Forestry Strategies to Slow Global Warming
by Mark C. Trexler
World Resources Institute
P.O. Box 4852
Baltimore, MD 21211.
81 pp., $15.50 ppd.

Arbor Day Newsletter

An illustrated feature article in the July/August 1991 issue of *Arbor Day* explains The National Arbor Day Foundation's fuelwood system being planned to heat and cool the new Lied Conference Center at The National Arbor Day complex in Nebraska City, Nebraska.

It also illustrates how trees reduce the net amount of carbon dioxide in the atmosphere. Single copies available free from the Foundation.

Conservation Trees Booklet

One of The National Arbor Day Foundation's most popular publications, this 24-page booklet demonstrates the vital use of trees in conservation. Energy-saving uses of trees are included and colorfully illustrated. Single copies free; $4.85 for 50 copies, $125 for 1,800 copies, plus $2.95 handling charge.

To order additional *Bulletin* copies... Friends of Tree City USA members may obtain a single copy of this or any of the 20 preceding *Tree City USA Bulletins* free of cost. Quantities of any issue are available at 25 for $6.25 or 500 for $100. To order: specify the issue number and quantity, and make your check payable to "National Arbor Day Foundation," 100 Arbor Ave., Nebraska City, NE 68410.

- No. 1 How to Prune Young Shade Trees
- No. 2 When a Storm Strikes
- No. 3 Resolving Tree-Sidewalk Conflicts
- No. 4 The Right Tree for the Right Place
- No. 5 Living With Urban Soils
- No. 6 How to Hire an Arborist
- No. 7 How to Save Trees During Construction
- No. 8 Don't Top Trees!
- No. 9 How to Write a Municipal Tree Ordinance
- No. 10 Plant Trees for America!
- No. 11 How to Prevent Tree/Sign Conflicts
- No. 12 What City Foresters Do
- No. 13 Trees for Wildlife
- No. 14 How to Kill a Tree
- No. 15 How to Recognize—and Prevent—Hazard Trees
- No. 16 How to Recycle Shade Tree Materials
- No. 17 How to Landscape to Save Water
- No. 18 Tree City USA Growth Award
- No. 19 How to Select and Plant a Tree
- No. 20 A Systematic Approach to Building With Trees
- No. 21 How Trees Can Save Energy

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To receive a subscription to the *Tree City USA Bulletin*, and to become more involved in the community forestry movement in your town and throughout America, send a $10 dues-donation to Friends of Tree City USA, National Arbor Day Foundation, 100 Arbor Ave., Nebraska City, NE 68410. Make your check payable to "National Arbor Day Foundation."

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